

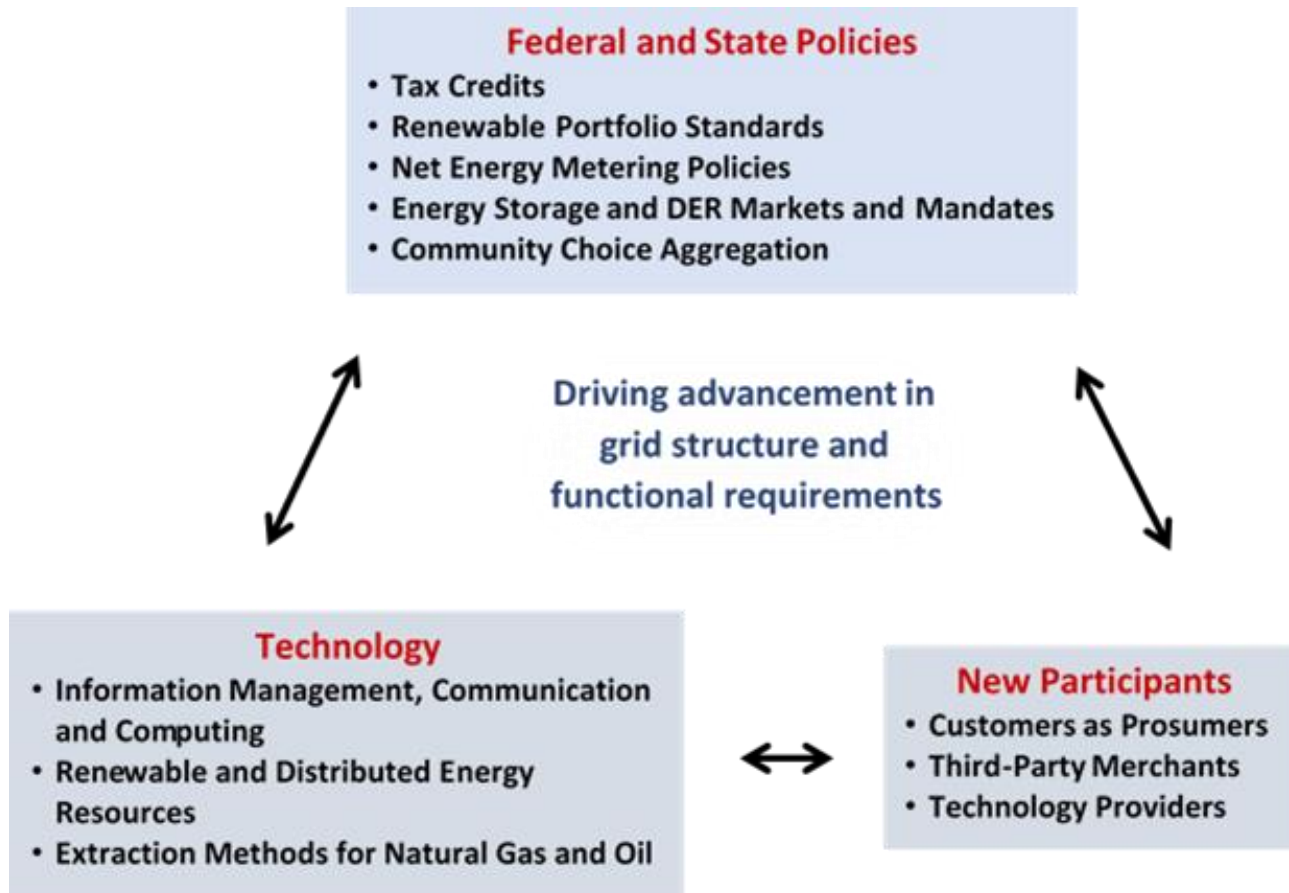


# Considerations for a Modern Distribution Grid

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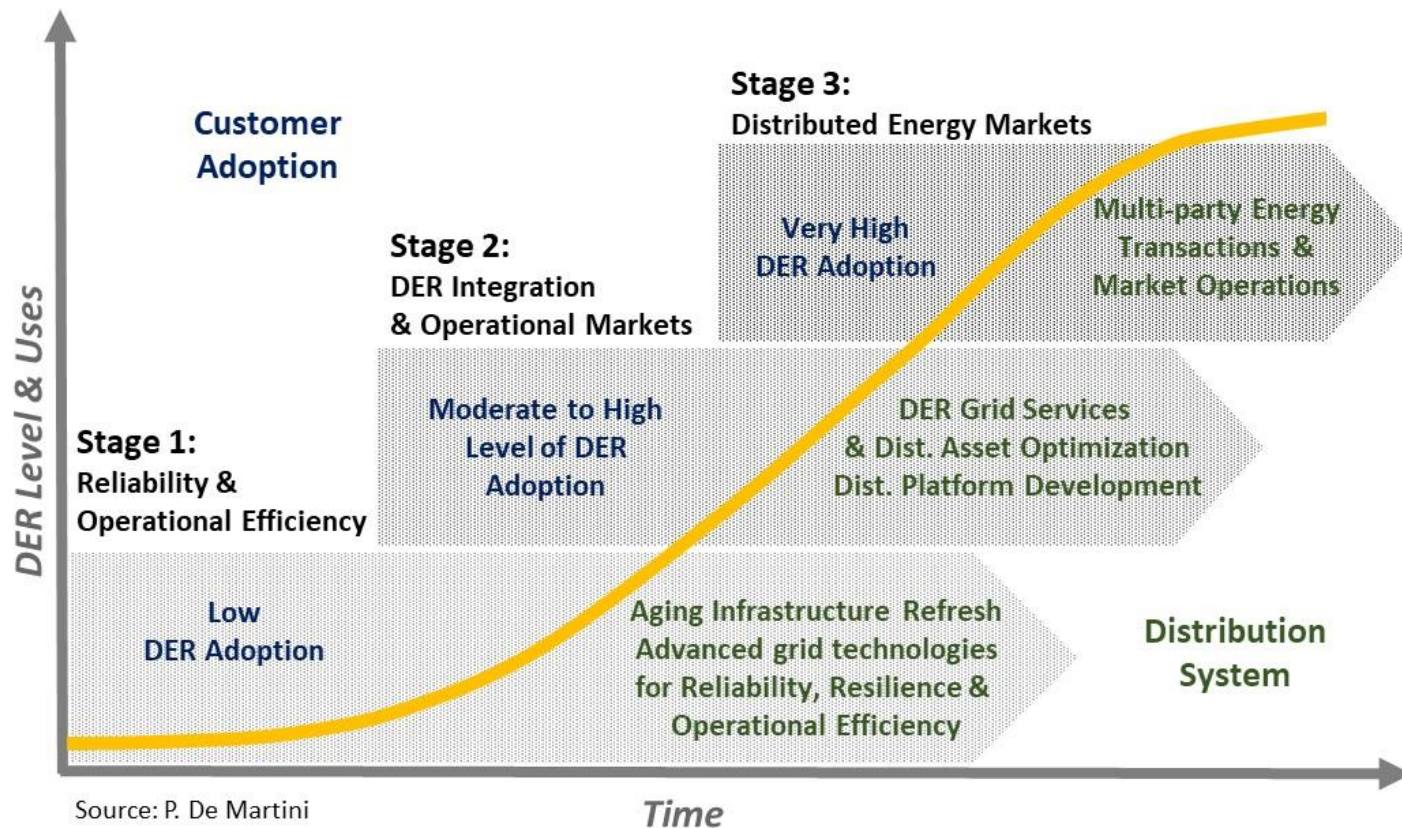
# Influencing Factors for Grid Modernization

“The challenge is to manage the transition and related operational and market systems in a manner that doesn’t result in an unstable or unmanageable system.”  
from Grid 2020, Resnick Institute Report, Sept 2012



# Distribution Grid Evolution

US distribution systems currently have Stage 1 functionality - a key issue is whether and how fast to transition into Stage 2 functionality



# Modern Distribution Grid Report

A rigorous approach to support development of grid modernization strategies and implementation plans based on best practices

## **Volume I:** Maps Grid Modernization Functionality to Objectives

- Grid architectural approach that maps grid modernization functionality to state objectives within a planning, grid operations & market operations framework
- **Enables evaluation of functionality required to meet a specific objective**

## **Volume II:** Assessment of Grid Technology Maturity

- Assessment of the readiness of advanced grid technology for implementation to enable functionality and objectives identified in Volume I.
- **Enables evaluation of technology readiness for implementation**

## **Volume III:** Implementation Decision Guide

- Decision criteria and considerations related to developing a grid modernization strategy and implementation roadmap with examples to illustrate application
- **Enables development & evaluation of grid modernization strategies and roadmaps for implementation**

# Beginning with Objectives

## Capabilities derived from state policy objectives

Objectives	CA	DC	FL	HI	IL	MA	MN	NC	NY	OR	TX
Affordability	•	•	•	•	•	•	•	•	•	•	•
Reliability	•	•	•	•	•	•	•	•	•	•	•
Customer Enablement	•	•	•	•	•	•	•	•	•	•	•
System Efficiency	•	•	•	•	•	•	•	•	•	•	•
Enable DER Integration	•	•	•	•	•	•	•		•	•	•
Adopt Clean Technologies	•	•	•	•	•	•		•	•	•	•
Reduce Carbon Emissions	•	•	•	•				•	•	•	•
Operational Market Animation	•	•		•			•		•		

From DSPx Volume 1 – Customer and State Policy Driven Functionality, version 1.1, March 23, 2017

Grid Capabilities			
Functions			
	Reliability, Safety & Operational Efficiency	DER Integration	DER Utilization
	● New		
	● Existing		
Market Operations	●	●	●
Grid Operations	●	●	●
Planning	●	●	●

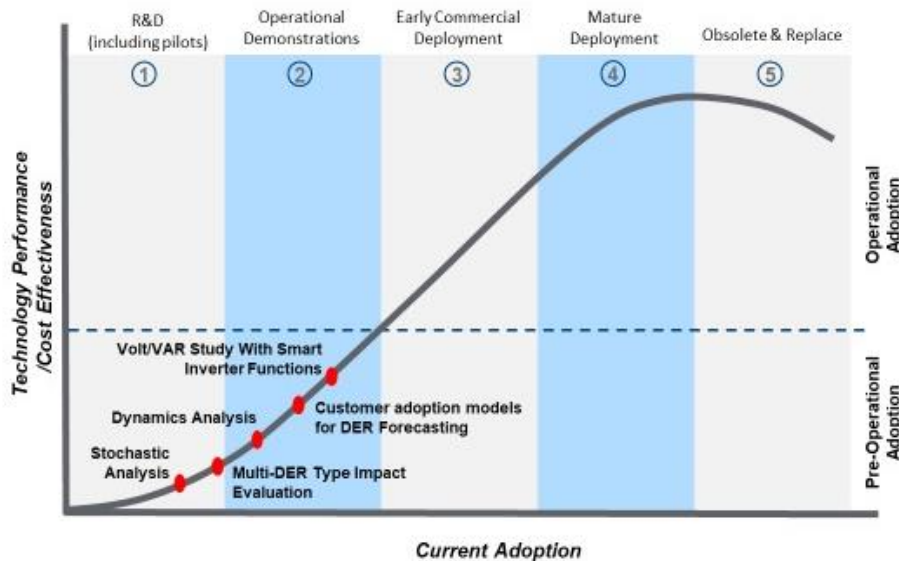
# Distribution Platform Capabilities

## Capabilities derived from state policy objectives

Distribution System Planning	Distribution Grid Operations		Distribution Market Operations
Scalability 3.1.1	Operational Risk Management 3.2.1	Situational Awareness 3.2.2	Distribution Investment Optimization 3.3.1
Impact Resistance and Impact Resiliency 3.1.2	Controllability and Dynamic Stability 3.2.3	Management of DER and Load Stochasticity 3.2.4	Distribution Asset Optimization 3.3.2
Open and Interoperable 3.1.3	Contingency Management 3.2.5	Security 3.2.6	Market Animation 3.3.3
Accommodate Tech Innovation 3.1.4	Public and Workforce Safety 3.2.7	Fail Safe Modes 3.2.8	System Performance 3.3.4
Convergence w/ Other Critical Infrastructures 3.1.5	Attack Resistance/Fault Tolerance/Self-Healing 3.2.9	Reliability and Resiliency Management 3.2.10	Environmental Management 3.3.5
Accommodate New Business Models 3.1.6	Integrated Grid Coordination 3.2.11	Control Federation and Control Disaggregation 3.2.12	Local Optimization 3.3.6
Transparency 3.1.7	Privacy and Confidentiality 3.2.13		

From DSPx Volume 1 – Customer and State Policy Driven Functionality, version 1.1, March 23, 2017

# Technology Maturity

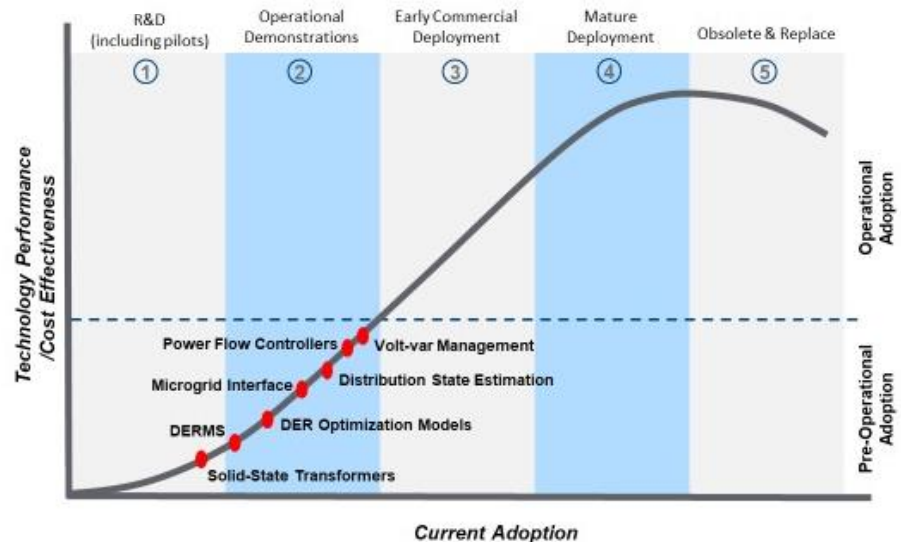


## Grid Planning

Primary gaps exist in modeling customer DER adoption, multi-type DER behavior impacts and resulting random variability on distribution circuits necessary in high/very high DER systems

## Grid Operations

Primary gaps exist in DER control & optimization systems, distribution state estimation models and needed grid power electronics to address operational dynamics



# Architecture Manages Complexity

The engineering issues associated with the scale and scope of dynamic resources envisioned in policy objectives for grid modernization requires a holistic architectural approach



So, pick-up a pencil

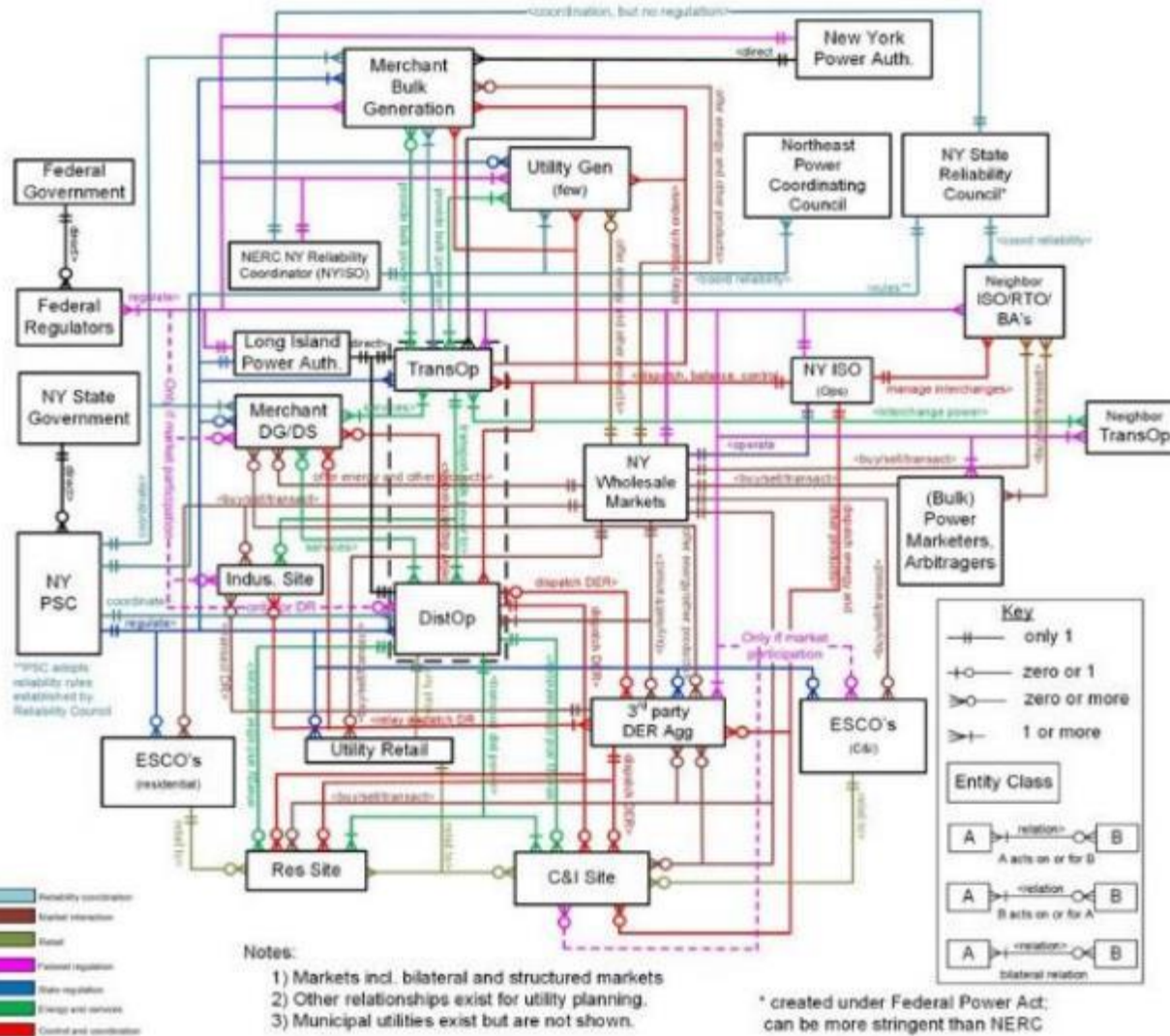


Before trying to  
hang windows



# Coordination Considerations

Industry Structure Model, New York 2015



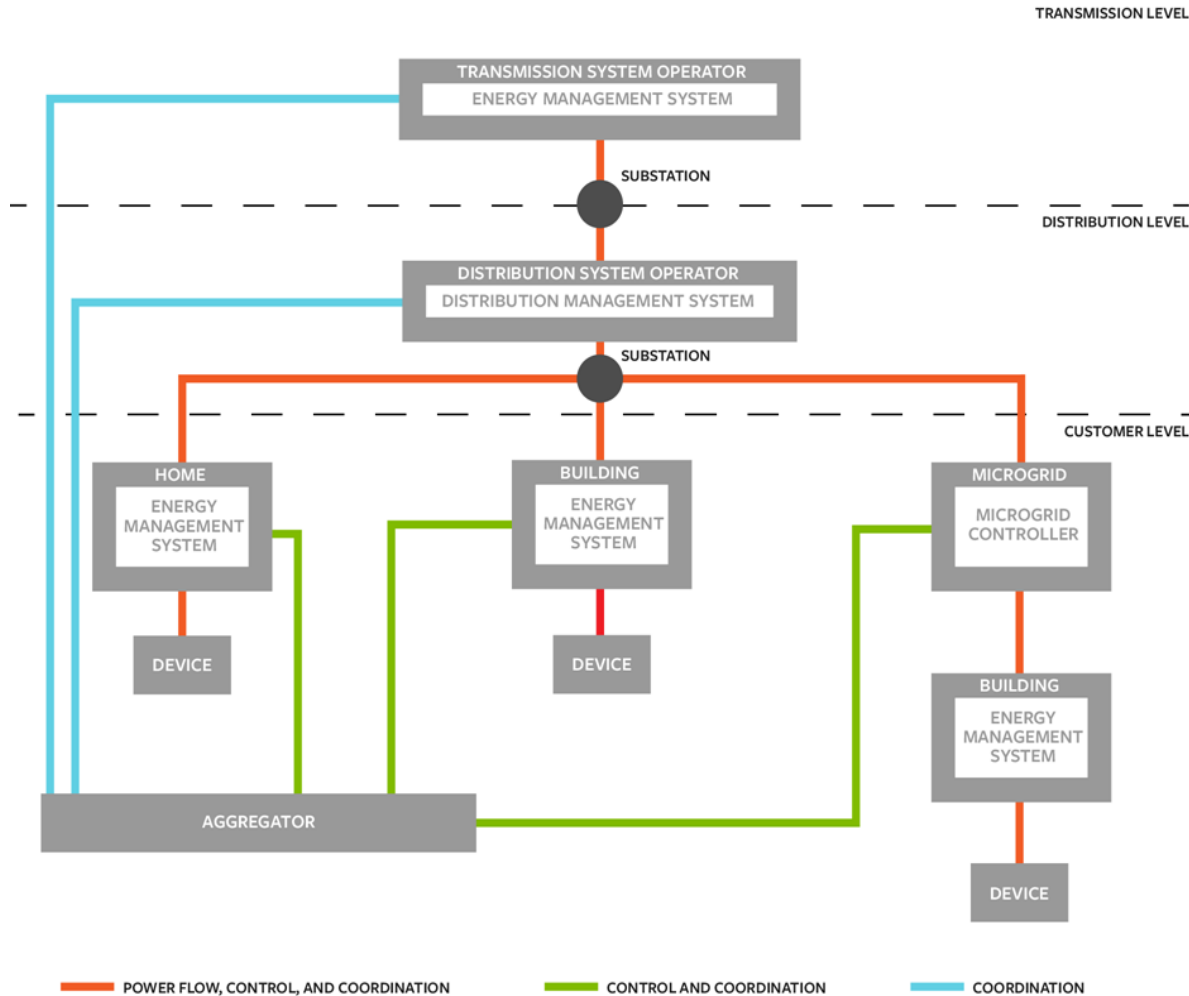
## Participants

Federal Government  
 Federal Regulators  
 NERC NY Reliability Coordinator  
 Northeast Power Coordinating Council  
 NY State Reliability Council  
 NY ISO (Ops)  
 Neighbor ISO/RTO/BAs  
 NY Wholesale Markets  
 Bulk Power Marketers/Arbitrators  
 Merchant Bulk Generation  
 Utility Generation  
 NY Power Authority  
 Long Island Power Authority  
 Transmission Operators  
 Neighbor Transmission Operators  
 NY State Government  
 NY PSC  
 Distribution System Operator  
 Utility Retail  
 Residential Customers  
 C&I Customers  
 ESCOs  
 Third-Party DER Aggregator

## Interaction Types

Reliability coordination  
 Market interaction  
 Retail  
 Fed/state regulation  
 Energy and services  
 Control and coordination

# Coordination Frameworks

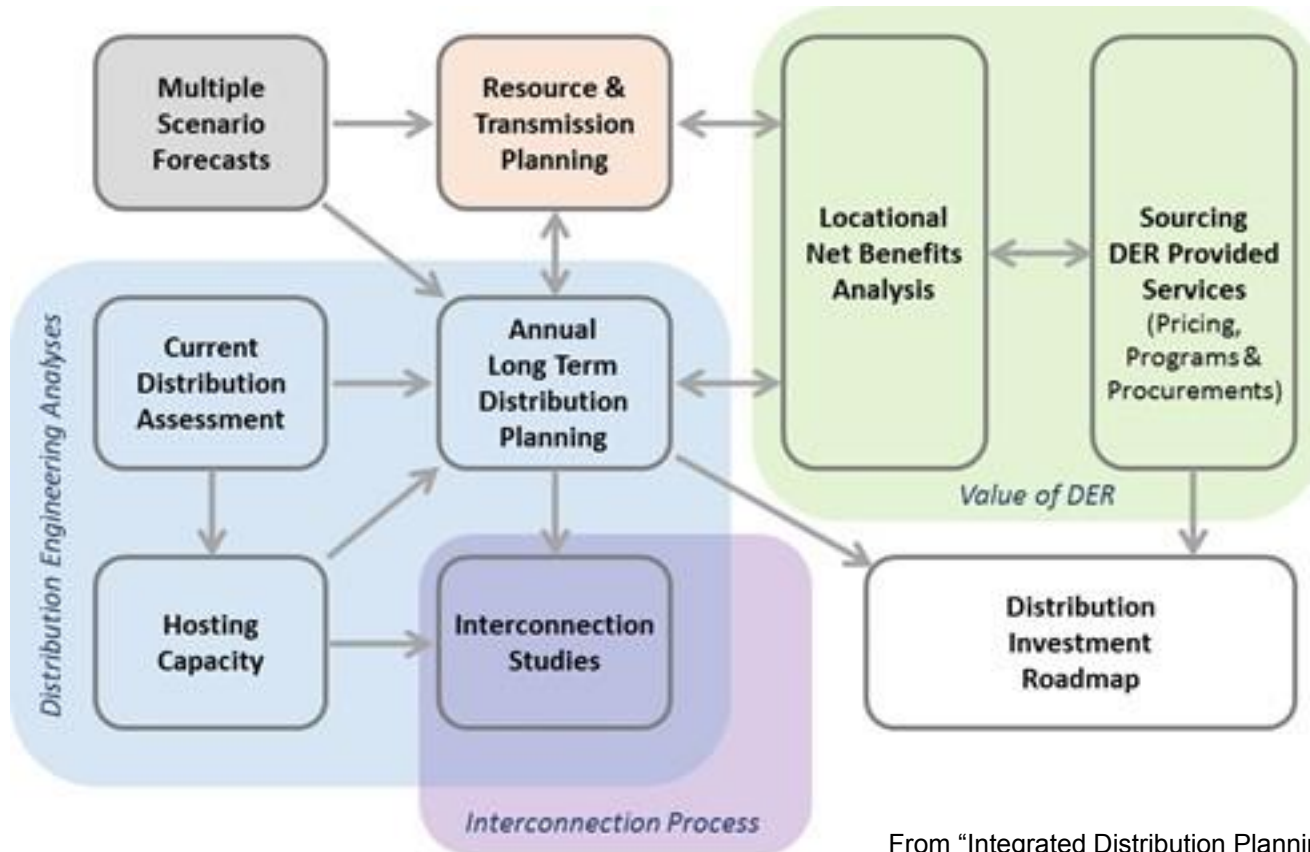


Laminar coordination permits local/system optimization

From JD Taft, Architectural Basis for Highly Distributed Power Grids: Frameworks, Networks, and Grid Codes, PNNL-25480, June 2016

# Integrated Planning Considerations

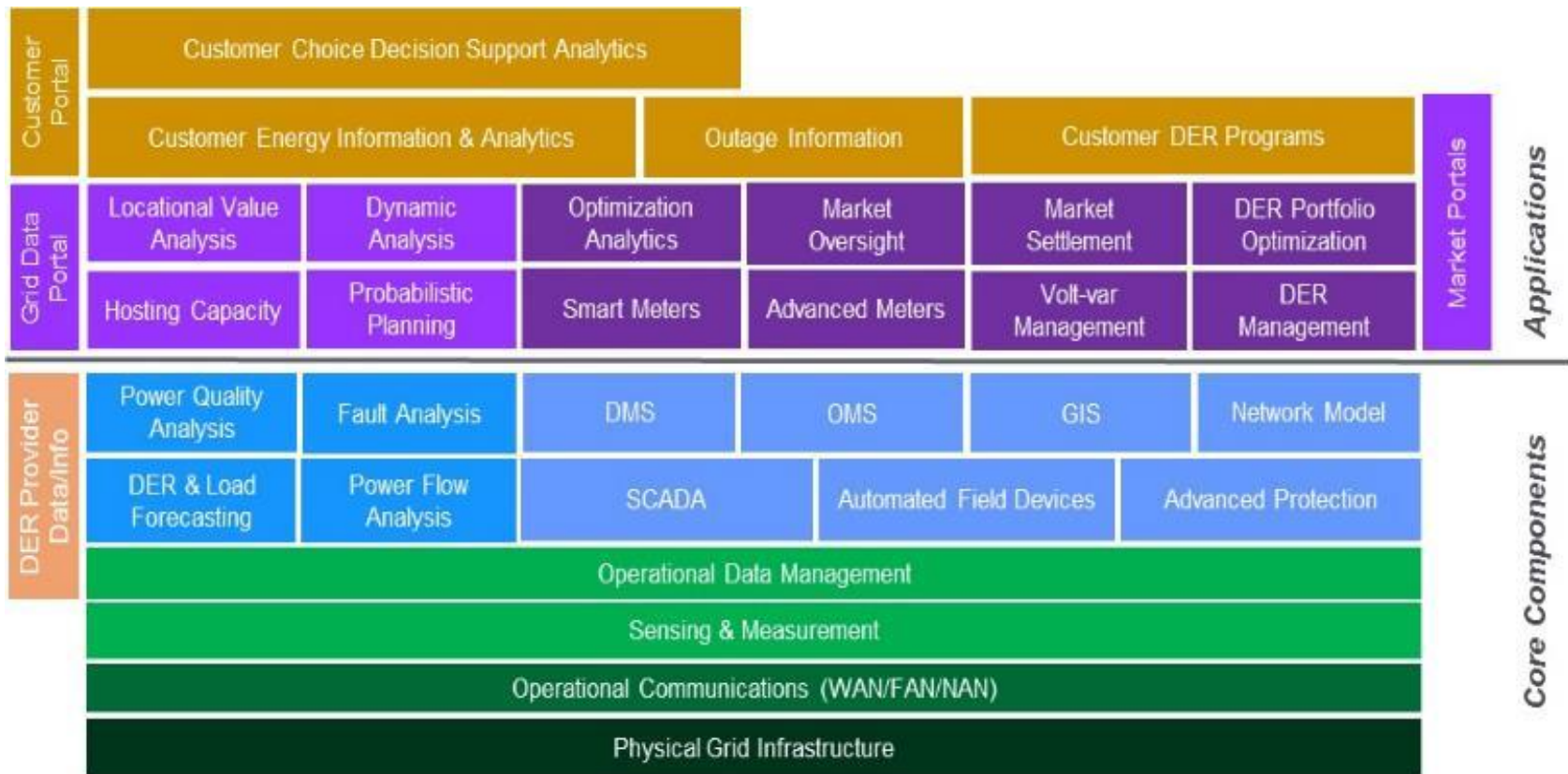
Integrated planning and analysis needed within and across the transmission, distribution and customer/3<sup>rd</sup> party domains



From "Integrated Distribution Planning", August 2016, prepared for the MN PUC, ICF International

# Platform Considerations

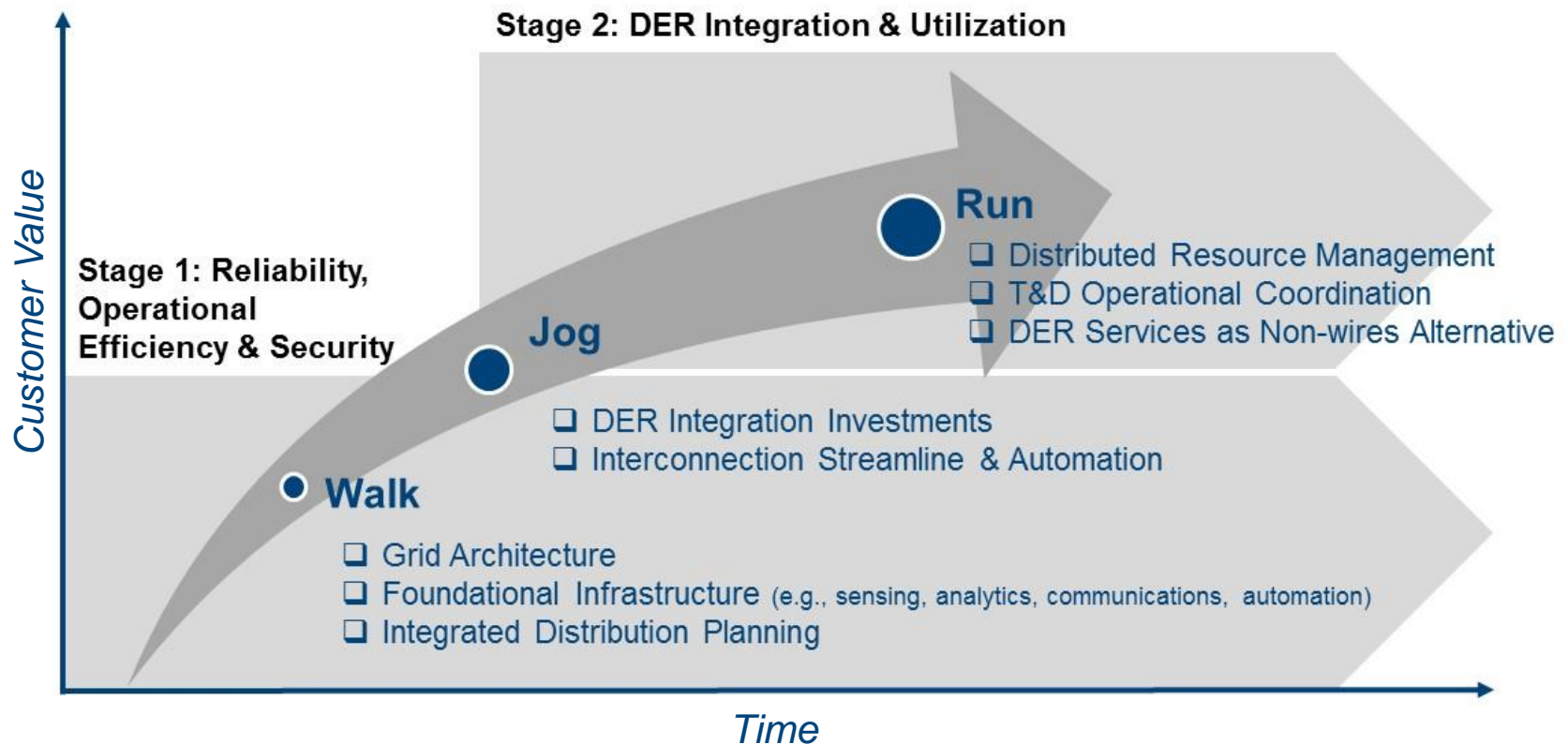
Core components form a foundational layer; applications sit on this foundation as additional functionality is needed



From DSPx, Volume 3 – Decision Guide, under review

# Timing & Pace Considerations

**Pace & scope** of investments are **driven by customer needs & policy objectives**. **Proportional deployment to align with customer value**



# DSPx2 Scope

## Task 1 – Technology Implementation Roadmap

To provide practical guidance on the proportional deployment of technology given the need to advance grid capabilities from legacy systems. Key efforts include:

- A Grid Modernization Technology Management Guide which will address, for example:
  - Development of grid observability strategies (application of sensors, including smart meters)
  - Field communication systems as multi-purpose networks
  - Advanced distribution system management systems
  - Integration of storage as a general purpose component
  - Integrated volt/var management with smart inverters and power electronics
  - Coordination frameworks
- A Practicum with NECPUC (June 2018) to address specific issues, for example, AMR vs AMI functionality, robustness of non-wires alternatives, needed GIS upgrades, and frameworks for assessing grid investments.
- A Reference Roadmap to identify key decision points in the process of advancing grid capabilities

## Task 2 – 2030 Grid Report

To examine key questions about the evolution of grid structure and function beyond 2020. For example:

1. How should the structure of electric circuits change to accommodate new technologies and operating modes?
2. Will existing power and energy markets still work in this environment?
3. How would the availability of large numbers of distribution level feed-ins change the relationship between distribution systems and bulk energy system operators?

# Thank You

## Contacts:

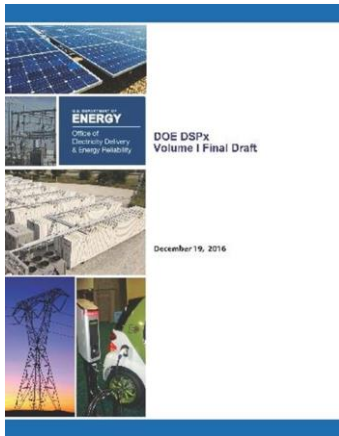
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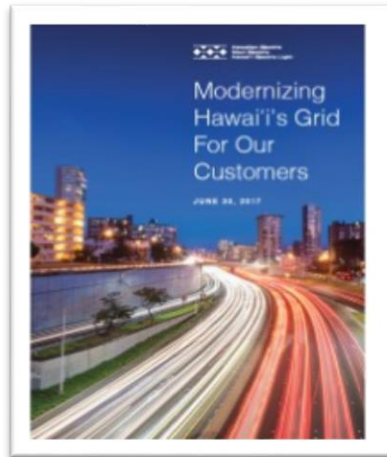
## References:

### Modern Distribution Grid Report



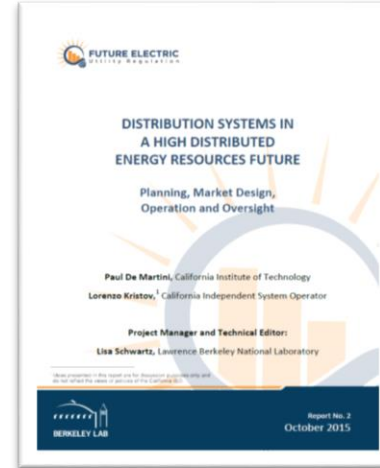
<https://gridarchitecture.pnnl.gov/modern-grid-distribution-project.aspx>

### Grid Modernization Strategy Using DSPx



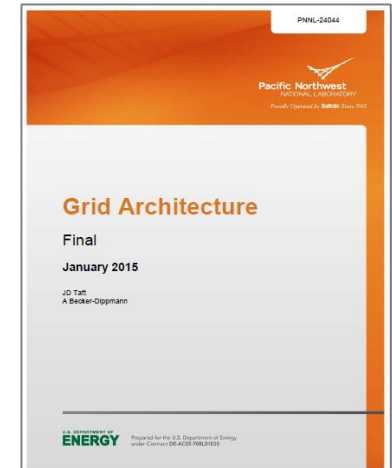
[www.hawaiianelectric.com/gridmod](http://www.hawaiianelectric.com/gridmod)

### DSO Paper



<https://emp.lbl.gov/projects/feur>

### Grid Architecture



<http://gridarchitecture.pnnl.gov>

